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ABSTRACT

Some patients may have to stay at home, however they may need also some rehabilitation exercises. Sometimes this is not possible due to several constraints: distance, cost, availability, etc. Traditionally, rehabilitation sessions are performed individually or in groups in the same place. Studies have shown that group sessions can lead to better motivation and results. In this paper, we propose a system that allows rehabilitation sessions, within a distributed group of people, under the computer-assisted supervision of a coach. The system makes use of wearable technologies, web applications and pervasive computing. Group awareness and self-awareness are enhanced for better motivation and results.

KEYWORDS

E-Health Virtual Communities, e-Training, Group Awareness, Pervasive Computing, Wearable Computing, Social Networks for Healthcare.

1. INTRODUCTION

In order to ensure that each user has the feeling “of being there” participating in a collaborative shared task, one must give him/her the feeling of being part of the ad hoc group. In the scientific literature the awareness of others is usually referred as “group awareness” (or sometimes reduced to the term awareness, which could be equivocated with other kinds of awareness unrelated to “group awareness”). Group awareness is the user's conscientiousness of the presence of the other users, and their associated actions within the group, which provides a context for his/her own activity. This context ensures the respect of the group goals and progress (Dourish, 1992). It is a compulsory element of Computer Supported Collaborative Work (henceforth CSCW) as users are expected to collaborate to perform a shared task. For the user, it varies from knowing that he/she is progressing in a group to seeing individuals' actions of his/her teammates, up to having different representations of each individual according to his/her actions and the environment in the collaborative system.

The proposed CSCW application in this paper is the practice of aerobics at home or in a mobile environment. Directing the application with specific motions/movements will be a specific case used for rehabilitation sessions, gymnastics is just a general case for the proposed application. Generally, gymnastics is done with a group in a given place (e.g. gymnasium). It may be difficult for the person to go to the gym because of constraints such as time schedule, temporal or permanent handicap, age or home hospitalization. So it may be interesting to find alternative systems for practicing it at home by joining an (online distributed) group of users. In other words, it can be convenient to practice gymnastics at home and feel “part of a group” thanks to data transmission using Web applications and the paradigm of pervasive computing. The pervasive technologies provide a means to collect, process and transmit data during a sports activity. Harvesting the user context and activities in the gymnastics session at home should help to enhance the group awareness for all users who are in the same distributed sessions. The primary objective is to give the users the feeling that

they are all in the same gymnastics session and they belong to a group. When implemented, such a system could help studying the effect of group awareness parameters in the group performance. Some CSCW sports systems already exist (see section 2). The main limitation is that they do not maintain group awareness. In most works the users are gathered / grouped according to their arrivals and not depending on their profiles and individual objectives. No group objective is suggested although this can be expected to strengthen group awareness. In this paper, the proposed system, TwittGym, deals with three dimensions: group awareness, self-awareness and how users gather under a common group objective.

The next section introduces a reference use case. Section 2 presents related works. Section 3 presents the principle of our system in order to maintain group awareness. Section 4 concludes this paper.

2. REFERENCE USE CASE

Ms. Alice is a patient suffering from a disease X which requires her intensive care. She had to attend special therapy sessions almost every day. She cannot move frequently because her health may deteriorate and the therapist's office is a long way from her house. Her therapy sessions are composed of specific physical exercises that help her to improve her health. Those exercises that she has to do are inspired by gym/aerobic exercises and are adapted for her disease. A physician should assist the session to ensure that patients perform the movements correctly. Ms. Alice is a person who really needs encouragement to improve and gets discouraged easily if not. She prefers to be part of a group, albeit a virtual one, sharing the same needs and getting feedback about her performance from her coach/physician and teammates.

3. RELATED WORK

CSCW software or groupware, in literature, is a term used by Greif and Paul M. Cashman in 1984 for the use of technology to support people in their work. Inspired by this concept, Mueller et al. (Mueller, 2007) proposes a use case in sports. It is a computer-mediated application considering sports activity as an input to achieve collective game experiences characterized by distance in-between users. Through the three prototypes that they developed and evaluated, Breakout, FlyGuy and Push'N'Pull, the authors demonstrated that movement-based interaction offers new opportunities for the design of CSCW. They infer that pervasive computing can help to bring the vision of sports over a distance into practice. It can provide unique experiences that facilitate, maintain and utilize social relationships between users.

Regarding the fitness activities using wearable devices and providing context awareness, the Mobile Personal Trainer (MOPET) is a wearable training system supporting outdoor activities (Buttussi, 2008). The system uses context-sensitive advice and is tailored to users. It is based on the context capture, the user model and the knowledge from a personal coach and a sport physiologist. It uses a heart rate monitor, a 3D accelerometer and a PDA with a GPS device, and allows users to visualize information on speed and heart rate, thereby allowing self-awareness, while being a single user application.

In February 2009, a remote rehabilitation project was launched, and will last 18 months (Taylor, 2009). The resulting system should enable patients suffering from chronic obstructive pulmonary disease to undertake rehabilitation exercises in a group. They exercise from their home through the use of a novel video-conferencing system. Information is sent over an Internet connection. The patient will be able to interact with other patients and their therapists. The primary motivation of this project is to allow a patient to easily attend such rehabilitation sessions in spite of the geographical constraints. In the meantime, studies have shown that patients improve their outcome when they belong to a group and perform the exercises together. There is no mention if this system is expected to be used and deployed using wearable computing.

Some other ubiquitous systems allow distant users to be aware of their mutual activities, motions and emotions. SHOJI (Shuzo, 2009) is an example of such a system. It allows receiving and sending ambient information, like room temperature, level of noise, presence or absence of the individuals, motions and emotions (based on voice analysis). The prototype presents three areas: showing information about the human activities, displaying information about the environment, and showing the anterior information (historic). Such devices promote group awareness without having the feeling of being followed by a computer. It can therefore be referred to as a pervasive and ubiquitous system.

The previous systems are just a glimpse of the existing systems which allow us to supervise training activities or to do sports activities with a group. We can deduce the need for such applications in sports. But there is not yet a system that ensures the supervision and, at the same time, enhancement of group awareness. In the next section, we will present our system and particularly how it assists coaches in their tasks (e.g. putting together groups, providing evaluations, providing assistance, defining user profiles etc.) and enhances group awareness.

4. PROPOSAL FOR A DISTRIBUTED REHABILITATION EXERCISING SYSTEM

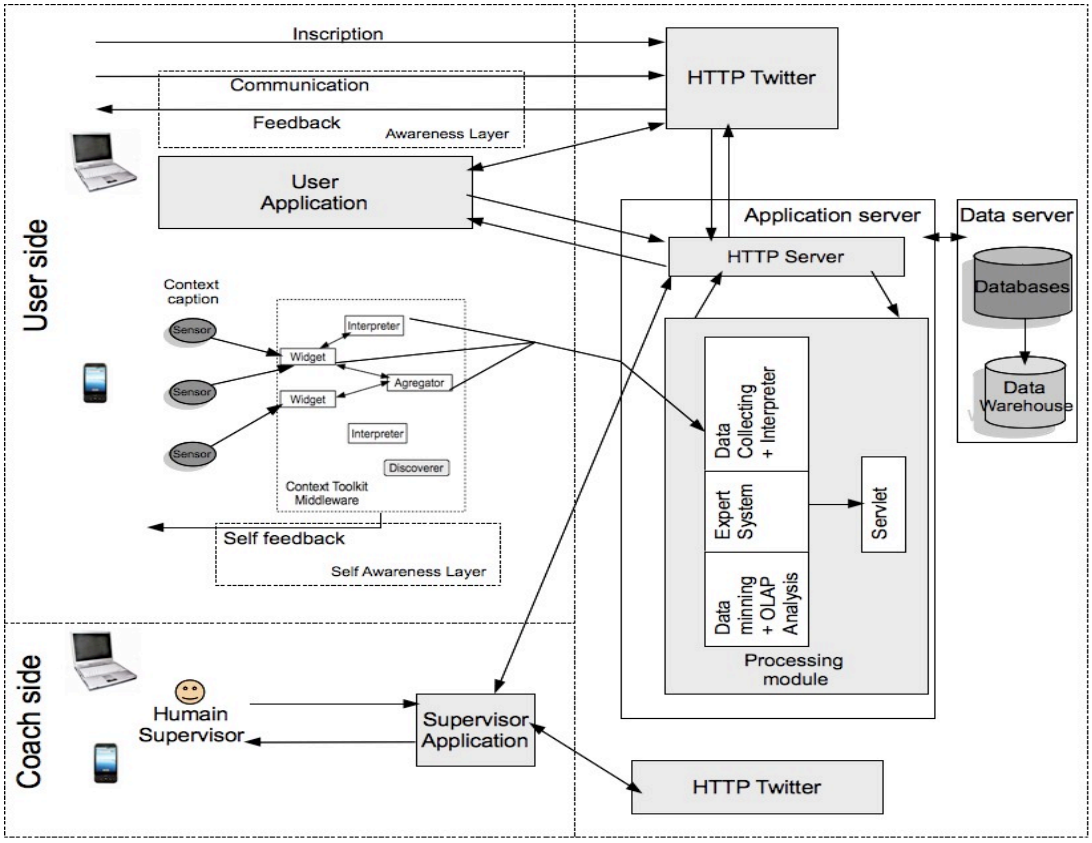
Attending gymnastics sessions through Internet may be a good alternative to people who cannot go to the gymnasium. However, doing it alone with videos may not match the users' expectations in the era of the Web 2.0 and nearly permanent social connectivity. The primary objective of this proposal is to provide tools to a human coach so that he can manage ad hoc communities for distributed rehabilitation exercising sessions.

4.1 Proposed architecture

The system architecture (figure 1) is composed of the user and the coach applications (which are local applications), the application server and the data server (which are remote applications).

The user and the coach applications are connected to the application server and to a social network using HTTP. We use the Twitter social network for our demonstration application. The choice of Twitter, the web based microblogging system, is based on the fact that it is a content distribution engine by and for people.

Figure1. TwittGym architecture



Researchers (such as Honeycut et al., 2009) predict that tools like Twitter will be used in formal collaborative contexts based on referring to what they are allowing at present. It offers too simple an API to be used. The application server collects data and information from the user and coach applications for processing. It processes algorithms to allow the interpretation and analysis of incoming data. Thus, it enables us to gather some gymnastics session statics and to assist the human coach. The data server contains all the used and useful data in the system. This software architecture allows the creation of ad hoc virtual communities, which are the gymnastics groups. To access the system a registration is needed, and it is provided by a Twitter account. The use of the Twitter platform as middleware ensures that such transactions occur in real time (with the use of Twitter's messages, 'tweets'). Twitter is also used as a social middleware - through it we can look for the friend of a user (friend relationship as defined by twitter). Moreover, we can use tweets for notification in the virtual community of friends on Twitter thanks to the prefix "@" (at) for direct public messages in the group, and also the prefix "#" (sharp) for performative messages.

4.2 Building the user's profile

The system considers the users' profiles. The user profile is the composition of psychological characteristics , potential role in a group, type of encouragements needed, availability, social network (using an existing social network like Twitter), age, sex and level of experience (from beginner to experienced). This profile can change over time thanks to the system update after each gymnastics session, and may be different based on the advice of a specialist. The psychological characteristics or profile lead to the motivation, which is the reason for doing sports (future collaboration with specialists will improve this point). Using the EMS questionnaire (Brière, 1995), we build the estimated motivation. Seven motivation types result from the questionnaire: Intrinsic motivation related to knowledge, Intrinsic motivation related to achievement, Intrinsic motivation related to stimulation, Extrinsic motivation - regulation type: identified, Extrinsic motivation - regulation type: introjected, Extrinsic motivation - regulation type: external and Disincentive. It is composed also by the dynamism of the person, his self-acceptance (which enhance the self-awareness), his possible role in a group (leadership...), the need for encouragements/pushes (which determines the type of targeted encouragements) and the acceptance of the others' reproaches. Using the EMS questionnaire and a part of the Personality test PER (Pépin, 1993) allows us to constitute the profiles. We launched it on the Web in order to get some net surfers' profiles.

4.3 Individual and group objective assignments

By referring to the user's profile, the system (human coach or algorithm) proposes recommendations on the criteria and profiles to build the groups and takes into consideration the user's preferences. The recommendations are how the coach wants to build the group, for example having a homogenous group according to one criterion and heterogeneous according to another one, and having some specific profiles, in a group such as having a leader in each group. In addition to the creation and management of user and group profiles, the system allows the definition of related objectives. There are objectives for each group and for each member. The system employs an algorithm, which takes user profiles as input, in order to assign individual or whole group exercise objectives,. A member of a given group can also suggest objectives for himself or for his group. When a session is started there is an agreement for those objectives. A validation is needed to inform the group members of personal and group objectives.

At the end of each session, there is a verification to check the objectives have been reached (individual and group levels). An evaluation is given. Each member of the group receives a summary of the session. An objective for the next session is calculated then the user's profile is updated. During the gymnastics session, a set of data concerning the user's physiological state (pulse, temperature, acceleration...) using the wearable computing technologies (sensors, accelerometer...) is generated. We can use the sensors embedded in our mobile phones when the user is moving, or use existing solutions such as Sun SPOT for prototyping, a heart rate monitor with a 3D accelerometer, SenseCore, ConText (Contactless sensors), accelerometer embedded in WII motes... there are numerous examples. This data is processed and used to determine the state of the user in real time. Thus, it allows determining if the user is doing his/her movements well and also the performance regarding the fixed objectives. The result of the interpretation of data is shown to the user (self-awareness, own perception of the image/presence the user is sending to the group) also to the entire group

and the coach (group awareness). Thereby, self-awareness is highlighted with the aim of letting the user know what is being sent, and urge him/her to improve. This can also suggest to other users to assist him if necessary.

4.4 Group awareness

Results are visualized differently according to the mobility of the user (it is different for the one who is doing his/her session outside with just his mobile phone and for the one who is doing it at home using his computer or television). Everyone is aware of the state of his/her teammates, their performance and how close they are to reaching their objectives. So members can encourage and motivate their teammates during the gymnastics session, and without it causing too much inconvenience to the user who is currently doing his gym session. The system (human coach or automata) can also encourage the entire group or a specific member. The encouragements are visual (using textual encouragement) or audible (using an audio channel) according to the mobility of the user, as in the case of the visualization of the results. Encouragements can, in this case, be better targeted. Indeed the coach side knows already the type of encouragements needed through profile acquisition and evolution. Having the cited information about others, their evolution and physiological states but also feedback and encouragement from the supervisor and/or their teammates, are elements that lead to the development of the group awareness.

5. CONCLUSION

In this paper we have proposed an approach for rehabilitation exercising within ad-hoc virtual communities in a collaborative pervasive environment,. This approach is based on user profiling which is composed of various parameters such as patient motivation and psychological profile (both extracted from questionnaires). Our approach uses wearable computing and pervasive technologies for feature extraction. It is a step towards doing sports activities within a group despite practical or geographical constraints, for instance, staying at home. Group constitution is very important for the individuals, especially for feeling integrated and for keeping motivated (receiving targeted encouragements, participating in a common goal). Our next step will consist in a semi-automated group construction algorithm for the system to consider jointly the user profile and objectives, and the group's objectives.

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